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**ACOUSTICAL ASSESSMENT**

OF

**EFFICIENCY UPGRADE**

AT

**ALCOA PINJARRA REFINERY**

FOR

**ALCOA WORLD ALUMINA AUSTRALIA**

BY

**HERRING STORER ACOUSTICS**

AUGUST 2003

OUR REF: 2206-1-03029-6-6

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Base Refinery: 2003 Model with 2 Alinta Co-Gen Units  
Upgraded Refinery: Base Refinery plus Efficiency Upgrade

## 1.0 UPGRADE NOISE ASSESSMENT SUMMARY

The proposed Pinjarra Efficiency Upgrade is able to comply with the noise emission objectives of the Regulations providing noise control measures as outlined in this report are incorporated into the upgrade design.

Under worst case propagation conditions, the overall noise level from the Alcoa Pinjarra Alumina Refinery, must be no greater than 35 dB(A) at any neighbouring noise sensitive premises. The predicted noise level from the proposed Pinjarra Efficiency Upgrade with noise control as detailed in this report at the nearest noise sensitive premises south of Napier Road is 34 L<sub>A10</sub>, which is an increase of 0.1 dB(A) to the 'base refinery' immission level of 33.9 L<sub>A10</sub>. An increase in overall noise level emission of 0.1 dB(A) is considered to be undetectable by the human ear and the overall level remains below the 35 L<sub>A10</sub> 'assigned level' under the Environmental Protection (Noise) Regulations 1997.

Noise control measures for the proposed efficiency upgrade include:

- Upgrading of pumps and piping to include design changes to reduce pump cavitation noise and excessive throttling of pumps which are two major causes of high noise emissions from pump / piping systems. Where appropriate new pump drives are to incorporate triple variable speed drives to eliminate cavitation and excessive throttling. The reduction in existing pump cavitation and throttling is expected to reduce current noise emissions, which will offset the marginal increase in noise due to new or larger pump installations in some locations.
- Provision of an acoustic shroud over the proposed new mill drum. The proposed mill is also shielded from southern residences by the bauxite stockpile.
- Full enclosure of the proposed additional blowers in calcination and provision of adequate intake and discharge silencers (similar to Wagerup Unit 4 blower)
- Provision of high efficiency fans and best practise design for the proposed new seed filtration building.
- Attenuation of steam valves and pipework breakout noise for the additions to building 42 and for the existing building 42 steam valves.
- Upgrade of the oxalate kiln, which will attenuate fan noise currently emitted from the stack.

It is worth noting that the noise immission levels described herein relate to 'worst case' propagation conditions, and noise levels for much of the time will be significantly less at residential locations.

## 2.0 INTRODUCTION

Herring Storer Acoustics was commissioned by Alcoa World Alumina Australia, Pinjarra Refinery to undertake an acoustic assessment of noise emissions for the proposed efficiency upgrade. The proposed plant incorporates a number of acoustic attenuation measures, detailed in the body of this report.

The objectives of the study were to:

1. Determine by modelling, the noise level propagation to areas surrounding the Pinjarra Refinery for the proposed efficiency upgrade in combination with the base refinery incorporating two co-generation units.
2. Compare the predicted noise level immissions to the Environmental Protection (Noise) Regulations 1997 'assigned level'.
3. Where it is found that the efficiency upgrade noise emissions will contribute to the existing noise levels and result in a possible exceedance of the 'assigned level', determine options to reduce the resultant noise levels at receiver locations so that the overall refinery noise emissions comply with the Regulation requirements.

The assessment of the Pinjarra efficiency upgrade has primarily been based on information supplied by the Alcoa Hatch Engineering Alliance, file data for existing similar equipment at the Pinjarra Alumina refinery and measurement of similar equipment at the Alcoa Wagerup Alumina refinery. The Alcoa Pinjarra Refinery noise model has been developed during ongoing studies for Alcoa World Alumina Australia.

### 3.0 ACOUSTIC CRITERIA

Environmental noise is governed by the Environmental Protection (Noise) Regulations 1997. These Regulations stipulate maximum allowable external noise levels determined by the calculation of an influencing factor which is then added to the base levels shown below. The influencing factor is calculated for the usage of land within the two circles, having radii 100 metres and 450 metres from the premises of concern.

**TABLE 3.1 - BASELINE ASSIGNED OUTDOOR NOISE LEVELS**

Premises Receiving Noise	Time of Day	Assigned Level (dB)		
		L <sub>A 10</sub>	L <sub>A 1</sub>	L <sub>A max</sub>
Noise sensitive (residential)	0700 - 1900 hours Monday to Saturday	45	55	65
	0900 - 1900 hours Sunday and Public Holidays	40	50	65
	1900 - 2200 hours all days	40	50	55
	2200 hours on any day to 0700 hours Monday to Saturday and 0900 hours Sunday and Public Holidays	35	45	55

Note: The L<sub>A10</sub> is the noise level exceed for 10% of the time.  
The L<sub>A1</sub> is the noise level exceed for 1% of the time.  
The L<sub>Amax</sub> is the maximum noise level.

The above levels are conditional on no annoying characteristics existing in the noise of concern, such as tonality, amplitude modulation or impulsiveness. If such characteristics exist and cannot be practicably removed, then any measured level is adjusted according to Table 3.2 below.

**TABLE 3.2 - ADJUSTMENTS TO MEASURED LEVELS**

Where <b>tonality</b> is present	Where <b>modulation</b> is present	Where <b>impulsiveness</b> is present
+5 dB(A)	+5 dB(A)	+10 dB(A)

Note: these adjustments are cumulative to a maximum of 15 dB.

Since noise from the refinery plant will be present for more than 10% of the time, it is the  $L_{A10}$  criteria which must be met. The current (June 2003) noise emissions from the refinery do not attract an adjustment due to noise characteristic (refer 2003 Monitoring Report, Appendix A). This is a result of an extensive program of engineering noise control recently carried out at the Pinjarra Alumina Refinery to attenuate a number of identified significant tonal noise sources.

The critical receiver locations for the Pinjarra refinery are the neighbouring rural residences with an assigned night-time noise criteria of 35  $L_{A10}$ . The critical residences for the proposed Pinjarra Efficiency Upgrade are on the south side of Napier Road (south of the refinery). Previous monitoring / modelling has established that residences to the north-east of the refinery are exposed to refinery immissions which are significantly lower than the 'assigned level'.

The most acoustically adverse weather conditions are the combination of source to receiver wind direction, wind-speed of 1-3 m/s and temperature inversion.

All noise levels in this report are  $L_{A10}$  values unless stated otherwise.

#### 4.0 METHOD OF ASSESSMENT

Modelling was undertaken using the computer programme SoundPlan 5.0 and the associated CONCAWE algorithms, which are most suited to industrial type noise and allow the incorporation of various meteorological factors. The computer modelling incorporates ground contours, meteorological conditions which reflect the 'worst case' measurable conditions (as determined by monitoring and wind analysis of the site, refer report Appendix A) and source sound power levels which are shown in Appendix B.

**TABLE 4.1 –WORST CASE MODELLING METEOROLOGICAL CONDITIONS**

Type	Night Time
Temperature (°C)	7
Humidity (%)	70
Wind Speed (m/s)	1.5
Wind Direction	Source to Receiver
Temperature Inversion (°C/100m)	2

Note: SoundPlan 5.0 does not allow an exact temperature gradient to be entered but a Pasquill Stability Factor. A Pasquill Stability Factor of Type E has been chosen to best represent the 2°C/100m temperature gradient. Using SoundPlan 5.0 a windspeed of 1.5m/s is the condition for most effective propagation of noise to distant receiver locations at low temperature climatic conditions. These conditions have been determined to be representative of 'worst case' climatic condition noise propagation for the Alcoa Pinjarra Refinery following extensive monitoring of refinery noise emissions.

A detailed acoustic model of the Alcoa Pinjarra Alumina Refinery has been developed using SoundPlan software and updated in an ongoing manner as various refinery noise control and the addition of the Alinta Co-generation project has occurred. The acoustic model output matches the noise monitoring levels relatively closely and provides a good representation of the refinery environmental noise emissions under 'worst case' climatic conditions. The acoustic model has been used for the prediction of the effects of both engineering noise control and addition of major equipment to the Alcoa Pinjarra Alumina

Refinery. The actual effect in noise immission at the Napier Road monitoring location of the completed projects reasonably matches the acoustic model predictions. The acoustic model is therefore considered a useful tool for the prediction of noise emissions for the proposed Pinjarra Efficiency Upgrade project.

## 5.0 REFINERY NOISE EMISSION HISTORY

~1997: Preliminary modelling of Pinjarra Refinery using ENM

~1998: Independent review of modelling & upgrade of model

~2000: Upgrade of noise model to SoundPlan

~2002: Tonal Noise Control Project Commences

~2002: Assessment / Approval of Alinta Co-generation project (on site)

2003: Tonal Noise Control Project Completed

2003: Monitoring of Refinery Immission at Napier Road

## 6.0 REFINERY ENVIRONMENTAL NOISE STATUS

A six week noise monitoring program at the Napier Road monitoring location was completed mid July 2003. The monitoring program was targeted at climatic conditions known to result in "worst case" conditions for sound propagation from the Pinjarra Alcoa Alumina Refinery to the rural residences to the south of Napier Road. These residences have previously been identified as the most significant in terms of noise immission due to the refinery.

Over the monitoring period a total of seven nights were selected for detailed noise measurement and observation based on Pinjarra specific Bureau of Meteorology forecasts for this project.

Measured noise levels varied depending on climatic conditions, with the following typical "worst case" conditions being:

- a) Relatively calm, and suspected strong temperature inversion: 32 – 36  $L_{A10}$  noise levels
- b) Light NNE breeze: 30 – 33  $L_{A10}$  noise levels

The measured noise levels can be compared to the 36.4  $L_{A10}$  noise level which has been determined by computer modelling to be equivalent to the Environmental Protection (Noise) Regulation 1997 "assigned level" of 35.0  $L_{A10}$  at night-time for rural residences south of Napier Road. Refinery noise immission has been determined as not having any significant noise characteristic as per the Regulations.

It is noted that due to the relatively low natural background noise for rural properties near the refinery, the complying refinery noise immission is audible under certain climatic conditions. The noise control work carried out at the refinery in recent years has significantly reduced tonal noise immission from the refinery and been effective in reducing the audibility of the noise.

It was concluded that the Pinjarra Alcoa Alumina Refinery noise immission complies with the requirements of the Environmental Protection (Noise) Regulations.

## 7.0 PROPOSED EFFICIENCY UPGRADE NOISE CONTROL

Noise control measures for the proposed efficiency upgrade include:

- Upgrading of pumps and piping to include design changes to reduce pump cavitation noise and excessive throttling of pumps which are two major causes of high noise emissions from pump / piping systems. Where appropriate new pump drives are to incorporate triple variable speed drives to eliminate cavitation and excessive throttling. The reduction in existing pump cavitation and throttling is expected to reduce current noise emissions, which will offset the marginal increase in noise due to new or larger pump installations in some locations.
- Provision of an acoustic shroud over the proposed new mill drum. The proposed mill is also shielded from southern residences by the bauxite stockpile.
- Full enclosure of the proposed additional blowers in calcination and provision of adequate intake and discharge silencers (similar to Wagerup Unit 4 blower)
- Provision of high efficiency fans and best practise design for the proposed new seed filtration building.
- Attenuation of steam valves and pipework breakout noise for the additions to building 42 and for the existing building 42 steam valves.
- Upgrade of the oxalate kiln, which will attenuate fan noise currently emitted from the stack.

## 8.0 PREDICTED NOISE LEVELS

The proposed Pinjarra Efficiency Upgrade has been modelled using the acoustic modelling program 'SoundPlan 5.0', with resultant noise level contours as shown in Appendix C. Scenarios have been generated under 'worst case' climatic conditions for the following:

- Base Scenario: Refinery with two co-generation units (project approved and commenced)
- Upgrade: Base scenario (includes co-generation units) with the addition of the proposed Efficiency Upgrade noise sources

The results show the maximum noise level propagation from refinery to residences (north 10 degrees east, worst case propagation direction), under 'worst case' temperature inversion condition.

A summary of the overall received sound pressure levels at the southern residences under conditions of 7 degrees centigrade, 1.5 m/s downwind, 70% relative humidity and a Pascal Stability Class E are as follows:

**TABLE 8.1 – PREDICTED NOISE LEVELS AT SOUTHERN LOCATIONS, dB(A)**

Description	Napier Road Monitoring Location	Napier Road Residence
Upgrade Noise Sources Only	19.7	18.3
Refinery + 2 Std Co-Gen Units	35.3	33.9
Refinery + 2 Std Co-Gen Units + Efficiency Upgrade	35.4	34.0

The above predicted noise levels show that the proposed Pinjarra Efficiency Upgrade has a limited impact on the overall noise emissions of the refinery to the southern residential locations.

A noise source ranking for the additional Pinjarra Efficiency Upgrade major plant based on noise levels at the Napier Road receiver location under 'worst case' climatic conditions is tabulated below. Noise levels at the Napier Road monitoring location (intersection of powerlines and Napier Road) are approximately 1.4 dB(A) higher than for the critical residence (nearest to the refinery).

**TABLE 8.2 –SOURCE CONTRIBUTION FROM EFFICIENCY UPGRADE TO IMMISSION AT NAPIER RD**

Noise Source Contributor	Contributed Noise Level, dB(A)
Mill #7 (with attenuation shroud)	17.1
Seed Filtration Building	15.5
Calciner Blower #9 (in enclosure)	8.2
45T Additional Cooling Tower Cell	7.5

## 9.0 DISCUSSION & ASSESSMENT

The most critical single point location for assessment of compliance with the Environmental Protection (Noise) Regulations 1997, are residences south of Napier Road, south of the plant.

The acoustic modelling predicts that the Efficiency Upgrade plant noise emission will not be tonal at locations near Napier Road.

The existing noise emissions from the Alcoa Pinjarra Refinery under 'worst case' climatic conditions are such that any new project must not increase a 35 LA10 receiver noise level. To achieve this will require the noise control measures outlined in section 7.0 of



this report. It is noted that discussion with design team leaders of all major upgrade areas has been carried out and noise control measures discussed have been allowed for in the design and project budget.

It is concluded that Pinjarra Efficiency Upgrade will have minimal impact on the overall noise emissions of the refinery.

Development of acoustic specification for major items of proposed plant is recommended during detailed design as a means of ensuring that noise emissions are controlled to ensure compliance with the Regulation requirements.

Verification of refinery noise compliance following implementation of the proposed Pinjarra Efficiency Upgrade and upgrade of the refinery acoustic model based on measurement of constructed / installed equipment is proposed at practical completion of the project.

For: **HERRING STORER ACOUSTICS**

Paul Drew

3 September 2003

# **APPENDIX A**

ALCOA PINJARRA REFINERY  
ENVIRONMENTAL NOISE MONITORING REPORT 2003



## **APPENDIX B**

EFFICIENCY UPGRADE PLANT SOUND POWER LEVELS

**Alcoa Pinjarra Refinery June03**  
**3rd octave spectras of the sources in dB(A) - Upgrade AMi II Jan03 - worst case inv, 1.5 m/s, 7 deg,N10**

**4**

Name	Lw	25Hz	31Hz	40Hz	50Hz	63Hz	80Hz	100H	125H	160H	200H	250H	315H	400H	500H	630H	800H	1000	1250	1600	2000	2500	3150	4000	5000	6300	8000	10000
Upgrade: Seed Filtration 44-2 W building	111.5	69.0	68.0	75.0	80.0	86.0	89.0	91.0	93.0	94.0	95.0	96.0	95.0	98.0	101.0	100.0	102.0	102.0	104.0	99.0	101.0	98.0	97.0	95.0	93.0	89.0	86.0	79.0
Upgrade: Seed Filtration 44-2 E building	111.5	69.0	68.0	75.0	80.0	86.0	89.0	91.0	93.0	94.0	95.0	96.0	95.0	98.0	101.0	100.0	102.0	102.0	104.0	99.0	101.0	98.0	97.0	95.0	93.0	89.0	86.0	79.0
Upgrade: 45T Cooling Tower cell	97.6	48.3	62.6	56.4	63.8	60.8	69.5	72.9	76.9	80.6	81.1	82.4	83.4	85.2	86.8	88.1	88.2	87.0	86.6	83.0	82.2	82.3	83.2	85.0	85.5	83.9	81.9	78.5
Upgrade: Seed filtration (44-2) E Vac Pu	99.0	56.0	58.0	66.0	69.0	77.0	83.0	83.0	81.0	84.0	84.0	87.0	83.0	86.0	88.0	87.0	88.0	89.0	89.0	89.0	88.0	86.0	84.0	83.0	81.0	77.0	73.0	68.0
Upgrade: Seed filtration (44-2) W Vac Pu	99.0	56.0	58.0	66.0	69.0	77.0	83.0	83.0	81.0	84.0	84.0	87.0	83.0	86.0	88.0	87.0	88.0	89.0	89.0	89.0	88.0	86.0	84.0	83.0	81.0	77.0	73.0	68.0
Upgrade: Seed Filtration W Pulp Stack	101.6	35.3	40.6	45.4	59.8	63.8	67.5	79.9	82.9	85.6	86.1	88.4	90.4	87.2	88.8	90.1	83.2	84.0	84.6	79.0	79.2	79.3	94.2	94.0	93.5	84.9	83.9	82.5
Upgrade: Calciner Blower #9	97.1	49.0	50.0	61.0	68.0	67.0	65.0	67.0	70.0	75.0	74.0	77.0	76.0	78.0	85.0	93.0	87.0	86.0	88.0	86.0	85.0	82.0	78.0	74.0	72.0	68.0	66.0	63.0
Mill #7: Pump	106.0	49.9	56.0	60.3	69.6	73.7	77.8	81.2	83.5	84.8	88.3	88.1	89.0	90.8	95.2	96.8	97.4	93.6	94.3	95.8	98.1	92.9	91.2	89.2	88.0	88.1	88.8	88.4
Upgrade: Seed Filtration E blowers (2)	97.3	48.0	49.0	58.0	62.0	71.0	72.0	73.0	82.0	75.0	77.0	84.0	80.0	84.0	86.0	86.0	87.0	87.0	86.0	88.0	88.0	87.0	85.0	81.0	78.0	73.0	69.0	63.0
Upgrade: Seed Filtration E Pulp Stack	101.6	35.3	40.6	45.4	59.8	63.8	67.5	79.9	82.9	85.6	86.1	88.4	90.4	87.2	88.8	90.1	83.2	84.0	84.6	79.0	79.2	79.3	94.2	94.0	93.5	84.9	83.9	82.5
Upgrade: Seed Filtration W blowers (2)	97.3	48.0	49.0	58.0	62.0	71.0	72.0	73.0	82.0	75.0	77.0	84.0	80.0	84.0	86.0	86.0	87.0	87.0	86.0	88.0	88.0	87.0	85.0	81.0	78.0	73.0	69.0	63.0
Upgrade: Mill #7 (covered) fall side	108.6	52.0	56.0	66.0	73.0	77.0	83.0	87.0	90.0	93.0	94.0	92.0	90.0	94.0	97.0	97.0	98.0	99.0	99.0	99.0	100.0	97.0	95.0	91.0	88.0	83.0	76.0	69.0
Upgrade: Mill #7 (covered) lee side	99.9	51.0	55.0	66.0	73.0	79.0	82.0	83.0	87.0	92.0	92.0	89.0	88.0	90.0	87.0	84.0	87.0	85.0	86.0	86.0	86.0	84.0	81.0	79.0	76.0	71.0	64.0	56.0
Upgrade: Mill #7 Standard In Chute	103.1	48.0	47.0	55.0	65.0	69.0	79.0	77.0	81.0	87.0	89.0	90.0	90.0	90.0	91.0	91.0	92.0	92.0	93.0	92.0	93.0	93.0	91.0	88.0	86.0	82.0	78.0	73.0

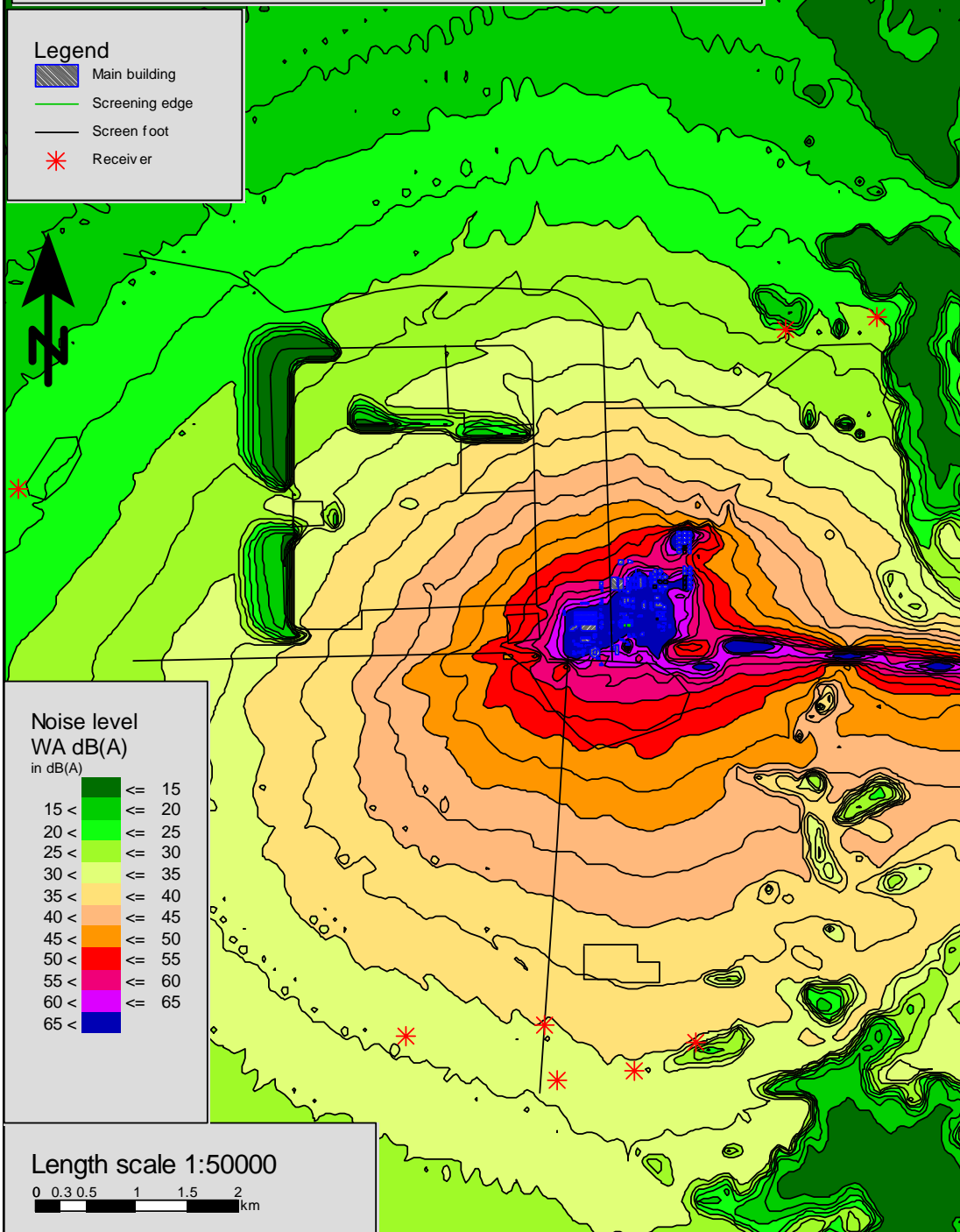
## **APPENDIX C**

### **PREDICTED NOISE CONTOURS FOR PINJARRA REFINERY 'WORST CASE' CONDITIONS WITH NORTH 10DEG EAST BREEZE & TEMPERATURE INVERSION**





- Base Refinery: 2003 Model with 2 Alinta Co-Generation Units
- Upgraded Refinery: Base Refinery plus Efficiency Upgrade

ALCOA PINJARRA REFINERY  
Efficiency Upgrade - Base (Refinery with 2 co-generation units)  
NNE 1.5 m/s wind, 7 degrees, Pasquil class E (temperature inversion)  
Project: 03029-6-6

- Legend**
- Main building
  - Screening edge
  - Screen foot
  - Receiver



ALCOA PINJARRA REFINERY  
 Efficiency Upgrade - Attenuated Mill Upgrade  
 NNE 1.5 m/s wind, 7 degrees, Pasquil class E (temperature inversion)  
 Project: 03029-6-6

- Legend**
-  Main building
  -  Screening edge
  -  Screen foot
  -  Receiver

